SOCIETIES AND ACADEMIES

LONDON.

Royal Society, January 19.—"On the Vibrations in the Field round a Theoretical Hertzian Oscillator." By Karl Pearson, F.R.S., and Alice Lee, B.A.

The object of this paper is to investigate the types of wave motion in the neighbourhood of a *theoretical* Hertzian oscillator. By a theoretical Hertzian oscillator the writers understand a Maxwellian "double point" of initial maximum moment $\pm El$. But as the actual oscillator has been shown by Bjerknes and others to give a damped wave train, they take the maximum moment to run down with the time, and to oscillate between the limits $\pm Ele^{-p_1t}$. This gives a wave train corresponding to that observed by Bjerknes and represented at a given distance by

$$Ce^{-p_1t}\sin(p_2t + \gamma).$$

The investigation for a "double point" with a *steady* wave train was originally made by Hertz himself, and has found its way into most of the current text-books of electro-magnetism. The theory there given, is insufficient for two reasons, both of which were recognised by Hertz himself, namely, because (i.) the actual oscillator has sensible extension, and (ii.) the wave train it gives forth is not steady.

The present paper only attempts to remove the latter objection to Hertz's original theory; like that theory it becomes less accurate as we approach nearer to an actual oscillator. The chief divergences between the present and Hertz's original theory actually fall in that portion of the field wherein his chief interference experiments were made.

The writers investigate the general theory of a double point with damped intensity, and replace the well-known Hertzian diagrams of the field by a more complete series of 56, representing the field for seven complete oscillations, and showing how the field for some twelve metres round the oscillator chosen, gradually falls to nearly $\frac{1}{50}$ of its maximum initial strength. These diagrams are entirely due to Miss Alice Lee, and involved a large expenditure of labour and time, which would, perhaps, not have been justified were any other graphic representation of a damped wave motion available.

The writers next deal with the type of waves propagated, their velocities and their phases. The following general conclusions are reached:—

(i.) Three waves of electro-magnetic force may be considered as sent out from the oscillator. These are:—

(*a*) A wave of purely transverse electric force.

(*b*) A wave of electric force parallel to the axis, briefly termed the wave of axial electric force.

(*c*) A wave of magnetic force.

The waves of axial electric and of magnetic force move outwards with the same velocity, which is, however, a function of the distance from the centre of the oscillator. The intensity of both forces for points on the same sphere varies as the cosine of the latitude, the polar axis being the axis of the oscillator.

The wave of transverse electric force is propagated with the same velocity at all equal distances from the centre of the oscillator, but this velocity differs from that of the two previous waves; further, the amplitude is independent of the latitude, being constant over any sphere. The velocity after the wave has reached a certain distance from the double point is always greater than that of the waves of magnetic and of axial electric force. Its excess over the velocity of light tends to become three times the excess of the velocity of the magnetic wave over the velocity of light; both the excesses decreasing asymptotically.

(ii.) The velocities of these waves undergo remarkable changes in the neighbourhood of the oscillator, but these changes extend to distances which are greater than those within which a great proportion of Hertz's interference experiments were made.

(iii.) The point of zero phase for both transverse and axial electric waves does not coincide with the centre of the oscillator, so that these waves appear to start from spheres of small but finite radius round the oscillator. A fourth wave dealt with by Hertz, namely, the wave of magnetic induction, does not, as he supposes, start with zero phase from the origin, but with a finite phase. The wave in the equatorial plane, largely relied upon by Hertz for his interference experiments "of the first kind," is a compound of the waves of transverse and axial electric force, and has a much more complex series of velocity changes than Hertz appears to have realised.

(iv.) The existence of the two electric force waves and the singular changes of the wave motion in the neighbourhood of the oscillator very possibly throw light on the difficulties which arise in Hertz's experiments. It would seem that such experiments should be made at distances greater than 6 to 7 $(\lambda/2\pi)$ from the centre of the oscillator, or, roughly, about a wavelength from the oscillator. In Hertz's case this amounts to about 10 metres—a distance at which Hertz rather terminated than started his interference experiments.

February 2.—"Sets of Operations in Relation to Groups of Finite Order." By A. N. Whitehead, M.A. Communicated by Prof. A. R. Forsyth, F.R.S.

The present paper is concerned with the Theory of Groups of Finite Orders. The more general object of the paper is to place this theory in relation to a special algebra of the type considered in the general theory of Universal Algebra. This special algebra, which may be called the Algebra of Groups of Finite Order, has many affinities to the Algebra of Symbolic Logic; and a comparison of it with this algebra is given in the last section of this paper.

The N symbols, or operations, are considered to be capable of addition according to the law

$$S+S=S.$$

This is the well-known law of addition in Symbolic Logic, and the introduction of numerical symbols as factors is thereby avoided.

The sum of a selection of the N fundamental operations, such as $S_p+S_q+S_r+S_t$, is called a set. If a set obeys certain special conditions it is called a group. The sum of the whole number (N) of fundamental operations, namely, $S_0+S_1+\ldots\ldots+S_{N-1}$, obeys these conditions. This sum is called the complete group, and all other groups are its sub-groups.

The first six sections of this paper are devoted to the detailed establishment of this purely algebraic view of the subject. At times the modification in treatment from that adopted in the standard treatises on the subject, such as Burnside's "Theory of Groups of Finite Orders," is slight.

The more special object of this paper follows directly from the changed point of view from which the Theory of Groups is here regarded. The idea of the group is no longer so absorbing; the set takes its place as the fundamental general entity which has to be investigated. Accordingly in this paper some of the general properties of sets are investigated. A set of operations has numerous groups associated with it, and these groups have many relations with each other. The fundamental idea of this part of the paper (*cf.* § 7) is the formation from a set H of an unending series of other sets, here called the successive powers of H, and in the notation of the algebra written $H^2, H^3, \ldots\ldots$ This series is called the power sequence of H. Any group which contains H also contains its power sequence. The power sequence is proved to have a periodic property (*cf.* § 9) which introduces a curious analogy to recurring decimals. This periodicity is the foundation of the rest of the paper. It governs the relations to each other of the various allied groups and sets. The periodicity is expressed by an equation of the form

$$H^{n+sm+q}=H^{n+q},$$

where m is called the period of H, and n the characteristic, and s and q are any integers including zero. The number of theorems relating to m is very large.

Linnean Society, January 19.—William Carruthers, F.R.S., Vice-President, in the chair.—Mr. H. W. Monckton exhibited specimens of *Mya arenaria*, Linn., from Norway. He and Mr. R. S. Herries (Sec. Geol. Soc.) had found a colony of these molluscs living on a sand-flat at the head of the Fjærland Fjord, about eighty miles from the open sea and where the water at the surface is fairly fresh. The great snowfield, the Sostedal, approaches close to the north-west side of the fjord, and at a level of only 3500 feet to 4000 feet above it, where glaciers descend into the valleys at the head of the fjord to within four miles of the mud-flat in question. The shells were for the most part small and thin, and this might be due to the freshness or to the coldness of the water, or both.—Dr. W. G. Ridewood read a paper, entitled "Some Observations on the Caudal Diplospondyly of Sharks," from which he concluded that the occurrence of twice as many vertebræ as muscle-segments is a secondary feature, but one of ancient date; and, further, that it is purely adaptive, being calculated to maintain a due proportion between the length of the centrum and the width of the body, without diminishing the length of the muscle-segments.—Mr. George Murray, F.R.S., and Miss F. G. Whitting (Newnham Coll., Camb.) communicated a paper on new Peridiniaceæ from the Atlantic, of which (in the absence of Mr. Murray through indisposition) an abstract was given by the Secretary.—Mr. A. J. Maslen read a paper on *Lepidostrobus* After remarking that the late Prof. Williamson's collection of fossil plants in the Natural History Museum contained a number. of slides which he had associated with *Lepidostrobus*, but which could not be referred with certainty to the particular vegetative organs to which they belonged, while it was difficult also to refer isolated sections of the same type of *Strobilus* to one another, he explained that the present paper gave the result of a re-examination of Williamson's slides of *Lepidostrobus*, undertaken at the suggestion of Dr. D. H. Scott. His object and endeavour had been to make out, if possible, at least some distinct forms; but he had found great difficulty in determining whether the observed structural differences in isolated sections were really of specific value or not. He considered it safer to adopt Williamson's *Lepidostrobus Oldhami* for a common type of structure, and by comparison to describe three marked variations (α, β, and γ). A clearly distinct form he described as a new species under the name *Lepidostrobus foliaceus*.

Entomological Society, January 18.—Annual Meeting.—Mr. Roland Trimen, F.R.S., President, in the chair.—It was announced that the following gentlemen were elected as officers and Council for 1899:—President, Mr. G. H. Verrall; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. J. J, Walker and Mr. C. J. Gahan; Librarian, Mr. G. C. Champion; and as other members of Council, Mr. W. F. H. Blandford, Dr. T. A. Chapman, Mr. H. St. J. K. Donisthorpe, the Rev. Canon W. W. Fowler, Mr. A. H. Jones, Mr. F. Merrifield, Mr. E. Saunders, Mr. R. Trimen, F.R.S., Mr. J. W. Tutt and Mr. C. O. Waterhouse.—The address of the retiring President was then read by the Secretary. In this, after a review of the present position of the Society, an account was given of the various experimental researches and observations made on the subject of seasonal dimorphism in lepidoptera from those of Weismann down to the evidence recently brought forward by Dr. Dixey on the existence of this phenomenon in Neotropical Pierinæ.

MANCHESTER.

Literary and Philosophical Society, January 24.—Mr. J. Cosmo Melvill, President, in the chair.—The President announced that the Council had awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium of fifteen guineas to Dr. Charles H. Lees. The presentation of the medal and premium had been fixed for February 28, when the Wilde Lecture would also be delivered by Prof. William Ramsay, F.R.S.—Dr. F. H. Bowman stated that he had recently seen a specimen of wheat grown in South Africa, consisting of about 420 stalks which were apparently produced from a single seed; each stalk had an ear containing on the average forty grains. The President and Mr. Charles Bailey agreed that the plant was most probably *Triticum compositum*, and Mr. Tristram stated that plants bearing 190 stalks had been grown in Lancashire.—The President exhibited specimens of *Eichhornia speciosa*, Kunth (the water hyacinth), and *Blitum virgatum*, L. (the strawberry blite), and also a series of leaves of the common holly (*Ilex aquifolium*, L.) showing every kind of variation.—Mr. Charles Bailey explained the structure of the peculiar permanent sheath which encloses the extremity of each root and rootlet of the *Pontederia* (*Eichhornia*) *crassipes*. The specimens exhibited to the members under the microscope showed that these sheaths were like the long finger of a glove in shape, and varied in size according to the age of the organ. The organic connection between the root and its sheath is found at the extremity of the root at the bottom of the sheath. The sheaths are of fair consistency, and are doubtless designed for the protection of the plant, which, by means of its inflated leaf-stalk, passes its life floating upon the surface of the water; the growing and tender extremities of the root are in this way guarded against the attacks of the smaller aquatic animals. The species of the cryptogamic genus *Azolla*, which also pass their existence in a floating condition, have a very similar root-sheath, but in their case the organ is only temporary, being discarded before the root reaches maturity.

PARIS.

Academy of Sciences, January 30.—M. van Tieghem in the chair.—Remarks by M. Faye on vol. i. of the *Annales de l'observatoire de Nice*.—Observation of the B-group in the solar spectrum, made at the summit of Mont Blanc, by M. A. de la Baume-Pluvinel. Photographs of the solar spectrum at Paris, Chamonix, and the summit of Mont Blanc, show that the group of B lines still remains at the highest elevation, but with an intensity much less than in the lower layers of the atmosphere.—Remarks on the preceding communication, by M. Janssen.—On the generalisation of the first method of Jacobi, by M. N. Saltykow.—On groups of the class $N - u$ and of degree N, transitive not less than $u - 1$ times, by M. Edmond Maillet.—On the problem of iteration, by M. Lémeray.—On the prolongation of analytical functions, by M. Émile Borel.—On orthogonal systems, by M. A. Pellet.—Doubly cylindrial surfaces and isothermal surfaces, by M. L. Raffy.—On surfaces of total constant curvature, by M. Tzitzéica.—On the lines of curvature of certain surfaces, by M. Blutel.—On curves of traction, by M. H. Bouasse.—Permanent torsion and the point of recalescence in steel, by M. G. Moreau. It is shown that for wires of different diameters with a sufficiently large initial torsion, the relation between the residual torsion T_r, the torsion T, and the diameter d, is given by $T_r = T - k/d$. Measurements of k for a well tempered steel wire raised to different temperatures by means of an electric current, showed that k remained constant up to about 300°, and then slowly diminished up to the point of recalescence, 715°, after which it remained constant.—Double refraction produced by the magnetic field related to the Zeeman phenomenon, by M. A. Cotton. In a previous paper it has been shown that the production of a magnetic field affects the optical properties of sodium vapour and nitrogen peroxide. An analysis of the light which reappears under the action of the field now shows that the explanation originally suggested is correct; for each of the new rays created by the field, the flame absorbs from the ray of white light only those vibrations identical with those it emits itself.—On the transparency of opaque bodies for luminous radiations of great wave-length, by M. Gustave de Bon. With a lamp wrapped in black paper, objects placed in an opaque box in contact with a phosphorescent zinc sulphide screen could be photographed.—On the differences existing between X-rays proceeding from one body, by M. G. Sagnac. The bundle of secondary rays emitted by a heavy metal exposed to X-rays, consists of rays of very different penetrative power, in every case less than that of the original rays.—The explosive power of acetylene at very low temperatures, by M. Georges Claude. The solubility of acetylene in acetone increases very rapidly as the temperature diminishes, acetone at −80° dissolving more than 2000 volumes of the gas. A platinum wire may be kept at a red heat in this solution without any explosion taking place. Liquid acetylene at −80° behaves similarly.—On the alloys of iron and nickel, by M. F. Osmond. A series of iron-nickel alloys was prepared, containing only small amounts of manganese and carbon, and in which the nickel varied in amount from 0·27 to 98·5 per cent. These alloys were heated, and the temperature at which their magnetic properties vanished noted: the curve showing the results has three branches, showing maximum transformation temperatures at 0, and 70 per cent. of nickel.—On the decomposition of carbon monoxide in presence of metallic oxides, by M. G. Boudouard. Carbon monoxide was passed over the oxides of nickel, cobalt, and iron, at 445°, and the rate of reduction measured. If the time of heating is sufficiently prolonged the decomposition is total with the oxides of nickel and cobalt.—On a new method of estimating carbon monoxide, by MM. Schlagdenhauffen and Pagel. Carbon monoxide completely reduces silver oxide at 60°, cuprous oxide at 215°–300°, and hence these oxides may be used to estimate the gas.—On some aromatic iodo-ketones, by M. A. Collet. A description of the preparation and properties of iodo-acetophenone, $C_6H_5.CO.CH_2I$, and the corresponding $CH_3.C_6H_4.CO.CH_2I$, and $CH_3.C_6H_4.CO.CHI.CH_3$.—Remarks on the preparation of the oxyethylamines, by M. F. Chancel. By the action of ammonia upon glycol chlorhydrin, the chlorhydrate of trioxyethylamine is readily obtained in a pure state.—Extraction and synthesis of the perfume of the jasmine flower, by M. Albert Verley. Preliminary attempts to isolate the essence by distillation with steam having failed, the perfume was taken up by fat in the usual way. This extracted with heavy petroleum oil and acetone gave only 40 gr., 90 per cent. of which was submitted to distillation under reduced pressure. A liquid was isolated of the composition $C_9H_{10}O_2$, which proved to be the methyl acetal of phenyl-glycol. It was synthesised by heating phenyl-glycol and formaldehyde with dilute sulphuric acid on the water bath.—Action of the benzidine diazochlorides of orthotoluidine and orthodianisidine upon acetylacetone, by M. G. Favrel.—On the reducing power of the tissues, by M. Henri Hélier. The reducing power of a tissue is defined as the quantity of oxygen that a gram of it is capable of removing from potassium permanganate to reduce the latter to Mn_2O_3. The present paper gives data for the liver and pancreas.—The clinical exploration of the renal functions and of phloridzic glycosuria, by M. Ch. Achard.—Action of the Turkish bath upon the internal organs, by MM. Bianchi and Félix Regnault.—On a hailstorm observed at Bizerte, by M. Voiellaud.—Barometric movements on the orthogonal of the meridian of the moon, by M. A. Poincaré.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—On the Reflection of Cathode Rays: A. A. C. Swinton.—On the Recovery of Iron from Overstrain: James Muir.—A Soil Bacillus of the Type of De Bary's *B. megatherium*: Dr. W. C. Sturgis.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

MATHEMATICAL SOCIETY, at 8.—On a certain Minimal Surface and on a Solution of $\nabla^2 V = 0$: T. J. Bromwich.—The Group of Linear Homogeneous Substitutions on mq Variables which is defined by a certain Invariant: Dr. L. E. Dickson.—On the Complete System of Differential Covariants of a Single Pfaffian Expression, and of a Set of Pfaffian Expressions: J. Brill.—Groups of Order p^3q: E. A. Western.—The Irreducible Concomitants of any Number of Binary Quartics: A. Young.—The Scattering of Electric Waves by an Insulating Sphere; A. E. H. Love, F.R.S.—The Figure of Jacobi with respect to a Linear System of Hyperquadrics: Prof. Schoute.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.—(Continuation of Discussion, if time permits): Electric Traction by Surface Contacts: Miles Walker.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Fifth Report to the Alloys Research Committee: Steel: Sir William C. Roberts-Austen, K.C.B., F.R.S.—Machinery for Book and General Printing: William Powrie.—Evaporative Condensers: Harry G. V. Oldham.

CAMERA CLUB, at 8.15.—The Heat of the Moon: The Earl of Rosse, F.R.S.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at 9.—Motion of a Perfect Fluid: Prof. H. S. Hele-Shaw.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—An Ampere-Meter and a Volt-Meter with a Long Scale: Benjamin Davies. (This will probably be read by Dr. Lodge.)

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Electrical Driving of Engineering Workshops: William Middleton.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh.

MONDAY, FEBRUARY 13.

IMPERIAL INSTITUTE, at 8.30.—Cuba: Richard Davey.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Canadian Rockies: a Search for Mount Hooker and Mount Brown: Prof. Norman Collie, F.R.S.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.— The Lake Superior Iron Ore Mines, and their Influence upon the Production of Iron and Steel: Jeremiah Head and Archibald P. Head.

ANTHROPOLOGICAL INSTITUTE, at 8.—The Arabs of the Indian Frontier: Sir T. H. Holdich, R.E., K C.I.E., C.B. (With Lantern Illustrations.)—Exhibition of Photographs by J. Guthrie Watson.

ROYAL HORTICULTURAL SOCIETY.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Annual General Meeting.

WEDNESDAY, FEBRUARY 15.

SOCIETY OF ARTS, at 8.—The Balloon as an Instrument of Scientific Research: Rev. John M. Bacon.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1898: Edward Mawley.—The Circulation of the Atmosphere: Prof. W. M. Davis.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Preceded at 7.30 by an Exhibition of Objects shown by Multiple-Colour Illumination: Julius Rheinberg.

ENTOMOLOGICAL SOCIETY, at 8.

OXFORD UNIVERSITY SCIENTIFIC CLUB, at 8—Chemical Theories under Discussion about the Year 1850—some Personal Reminiscences.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Reflex Electrical Effects in Mixed Nerve and in the Anterior and Posterior Roots: Miss Sowton.—The Characteristic of Nerve: Dr. A. D. Waller, F.R.S.—Observations on the Cerebro-spinal Fluid in the Human Subject: Dr. St. Clair Thomson, Dr. L. Hill, and Prof. Halliburton, F.R.S.—The Thermal Deformation of the Crystallised-Normal Sulphates of Potassium, Rubidium, and Cæsium: A. E. Tutton.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.—On the Genus *Lemnalia*, Gray, with an Account of the Branching Systems of the Order Alcyonacea: Gilbert C. Bourne.—On some African *Labiatae*, with Alternate Leaves: J. H. Burkill and C. H. Wright.—Report on the Marine Mollusca obtained during the First Expedition of Prof. A. C. Haddon to the Torres Straits: James Cosmo Melvill and Robert Standen.

CHEMICAL SOCIETY, at 8.—On the Absorption Spectrum and Constitution attributed to Cyanuric Acid: W. N. Hartley, F.R.S.—Ballot for the Election of Fellows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Recherches sur les Instruments les Méthodes et le Dessin Topographiques; Colonel A. Laussedat (Paris, Gauthier-Villars).—Elementary Hydrostatics: C. Morgan (Rivingtons).—Die Welt als That: Dr. I. Reinke (Berlin, Paetel).—West African Studies: M. H. Kingsley (Macmillan).—Vaccination; its Natural History and Pathology; Dr. S. M. Copeman (Macmillan).—Society for the Promotion of Engineering Education. Proceedings of the Sixth Annual Meeting (Columbia, Mo.).—Elementary Physiology: B. Moore (Longmans).—An Introduction to the Differential and Integral Calculus and Differential Equations: F. G. Taylor (Longmans).—Instinct and Reason: H. R. Marshall (Macmillan).—The Human Body: Prof. H. N. Martin, 5th edition (New York, Holt).—A Junior Course of Practical Zoology: A. M. Marshall and C. H. Hurst, 5th edition (Smith, Elder).

PAMPHLETS.—Licht-, Elektrizitäts- und X-Strahlen: R. Mewes, Zweite Ausgabe (Berlin, Krayn).—Sprachregeln für die Bildung und Betonung Zoologischer und Botanischer Namen: P. Kretschmer (Berlin, Friedländer).—Dietary Studies in Chicago (Washington).

SERIALS.—Contemporary Review, February (Isbister).—Photogram, February (Dawbarn).—Physical Society of London, Proceedings, January (Taylor).—Transactions of the Natural History Society of Glasgow, Vol. v., n. s., Part 2 (Glasgow).—Natural Science, February (Pentland).—Humanitarian, February (Duckworth).—Scribner's Magazine, February (Low).—National Review, February (Arnold).—Knowledge, February (Witherby).—Fortnightly Review, February (Chapman).—Journal of Botany, February (West).—L'Anthropologie, tome ix. No. 6.—Observatory, February (Taylor).—Geographical Journal, February (Stanford).—Record of Technical and Secondary Education, January (Macmillan).—Zeitschrift für Physikalische Chemie, xxviii. Band, 1 Heft (Leipzig).—Bulletin of the American Mathematical Society January (New York).—Monthly Weather Review, October (Washington).

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